

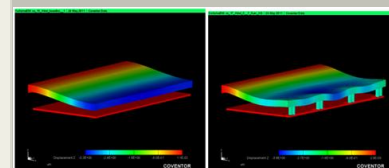
Enhanced Reliability MEMS Deformable Mirrors for Space Imaging Applications, Phase II

Completed Technology Project (2012 - 2015)



Project Introduction

The goal of this project is to develop and demonstrate a reliable, fault-tolerant wavefront control system that will fill a critical technology gap in NASA's vision for future coronagraphic observatories. The project outcomes include innovative advances in component design and fabrication and substantial progress in development of high-resolution deformable mirrors (DM) suitable for space-based operation. Space-based telescopes have become indispensable in advancing the frontiers of astrophysics. Over the past decade NASA has pioneered coronagraphic instrument concepts and test beds to provide a foundation for exploring feasibility of new approaches to high-contrast imaging and spectroscopy. From this work, NASA has identified a current technology need for compact, ultra-precise, multi-thousand actuator DM devices. Boston Micromachines Corporation has developed microelectromechanical systems (MEMS) DMs that represent the state-of-the-art for scalable, small-stroke high-precision wavefront control. The emerging class of high-resolution DMs pioneered by the project team has already been shown to be compact, low-power, precise, and repeatable. This project will develop a system that eliminates the leading cause of single actuator failures in electrostatically-actuated wavefront correctors – snap-through instability and subsequent electrode shorting and/or adhesion. To achieve this we will implement two innovative, complementary modifications to the manufacturing process that were proven successful in Phase I. We will develop a drive electronics approach that inherently limits actuator electrical current density generated when actuator snap-down occurs, and we will modify the actuator design to mitigate adhesion between contacting surfaces of the actuator flexure and fixed base electrode in the event of snap-down. This project will result in a MEMS DM with 2048 actuators and enhanced reliability driven by current-limiting drive electronics.



Results of FEA showing actuator deflection for the baseline actuator (left) and enhanced reliability actuator designs (right) at a critical voltage of 300V and 687V respectively.

Enhanced Reliability MEMS Deformable Mirrors for Space Imaging Applications Project Image

Table of Contents

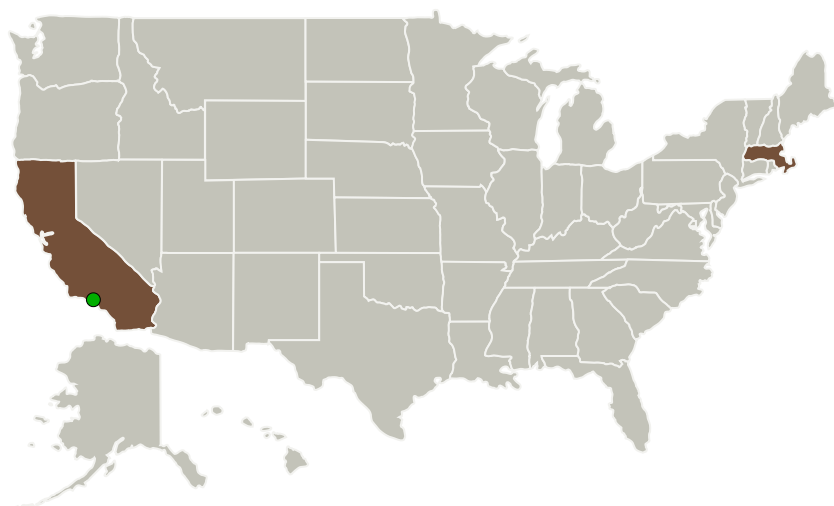
Project Introduction	1
Primary U.S. Work Locations and Key Partners	2
Project Transitions	2
Organizational Responsibility	2
Project Management	2
Images	3
Technology Maturity (TRL)	3
Technology Areas	3
Target Destinations	3

Enhanced Reliability MEMS Deformable Mirrors for Space Imaging Applications, Phase II

Completed Technology Project (2012 - 2015)



Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Boston Micromachines Corporation	Lead Organization	Industry	Cambridge, Massachusetts
● Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations

California	Massachusetts
------------	---------------

Project Transitions

▶ **April 2012:** Project Start

✓ **April 2015:** Closed out

Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/137387>)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Boston Micromachines Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Steven A Cornelissen

Co-Investigator:

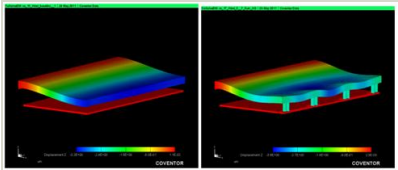
Steven Cornelissen

Enhanced Reliability MEMS Deformable Mirrors for Space Imaging Applications, Phase II

Completed Technology Project (2012 - 2015)



Images



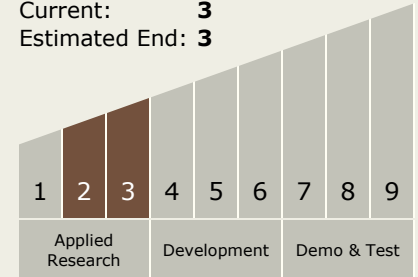
Results of FEA showing actuator deflection for the baseline actuator (left) and enhanced reliability actuator designs (right) at a critical voltage of 300V and 657V respectively.

Project Image

Enhanced Reliability MEMS
Deformable Mirrors for Space
Imaging Applications Project Image
(<https://techport.nasa.gov/image/134604>)

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX08 Sensors and Instruments
 - TX08.2 Observatories
 - TX08.2.1 Mirror Systems

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System